Remarks

This amendment is in response to the Official Action of June 4, 2003. Claims 1-22 remain in the case. Claims 1-8 have been rejected. Claims 9 and 10 have been objected to and claims 11-22 have been allowed.

The specification has been objected to on the basis that the March 28, 2002 amendment to the specification is alleged by the Examiner as introducing new subject matter. Specifically the Examiner objected to the March 2002 amendment of pages 33 and 34 of the specification as introducing new matter.

Since the Examiner has raised a new matter rejection, Applicants have herewith revised the changes to the specification introduced with the March 2002 Amendment so that the purpose for the changes and the fact that these changes do not introduce materially significant new matter can become more readily apparent. Some of the specification changes presented herein revert to the originally filed text.

legal standard is whether POSA would have thought inventor been in possession of added subj matter

Firstly, it should be understood that the material on these pages is intended to provide a mathematical model and explanation for the invention of processing a wafer with a hot gas while relying upon a quenching of the heat imparted to the wafer surface by the hot gas from the cooler bulk material of the wafer.

In order to obtain this quenching, a temperature differential must be maintained throughout the wafer material. This is extensively described throughout the specification and in particular in the description dealing with Figures 9 and 10 on pages 30 and 31.

Then on page 32 a section of the specification begins with the heading "Estimate for the exposure time to yield a high temperature differential". The intent of this sec-

tion is to derive a simple expression for a model that would give a good upper boundary to the hot gas heating (exposure) time needed to operate in the regime that yields a large temperature differential through the thickness of the wafer. The inventors made errors in the initial derivation, that included using the wrong value for the density of silicon in an example. These errors have been corrected in the amendment and the particular changes are discussed below.

The change to the original specification on Page 33 at line 14 involved correcting the temperature difference across the middle layer from $\Delta T/2$ to $\Delta T/4$. This enabled the subsequent analysis to assign temperature differentials of $\Delta T/2$ for the top layer and one half of that for each of the middle and bottom layers. This change corrects an inaccuracy in the 3-layer physical model used for the estimate as explained in the opening paragraph of this section in the original text.

The deletion from the original specification on Page 33 at lines 17 through 20 (The portion beginning with "Since the back layer ... to W/6") was made because there had been an inadvertent specifying of a heat transfer rate through the middle layer (expression page 33, line 20) as well as the temperature differential responsible for the heat transfer (see page 33, line 14). Actually one will result from the other. In the amendment of the specification there is an implicit assumption that the temperature differential will increase to some value while heat input into the top layer is transported through the middle layer. Consequently, specifying the heat transferred through the middle layer by the expression on line 20 page 33 and the related text of the original specification has been dropped in the amended version.

The changes to lines 22 and 23 of the original spec are then made to provide an upper value for the transfer of heat from the top layer to the middle layer with the re-

vised expression in line 25 being amended to read: (area) $W = k$ (area) $(\Delta T/4)$ / $(\Delta h/3)$.

This then logically leads to a slightly different expression for equation 15 as set forth below:

(15) $W = (3/4)k\Delta T/\Delta h$ and this logically leads to a slightly altered expression for equation 16 on line 5 of page 34 of the original spec as follows:

(16) $t_E < (4/9)\rho\, c_p \Delta h^2 / k$

The change in line 13 of page 34 corrected for the wrong value for the density of silicon, a quantity that is well known from publicly available texts.

It should not be overlooked that the intent of the section with the subtitle "Estimate for the exposure time to yield a large temperature differential" was to derive a simple expression that would give a good upper boundary to the hot gas heating (exposure) time needed to operate in the process regime that gives a large temperature differential through the thickness of the wafer. The inventors had several inaccuracies in the original derivation and used the wrong value for the density of silicon in an example.

Correction of these errors did not change the dependence of the exposure time, t_E, on the originally disclosed physical parameters, namely: the material density, ρ, heat capacity, c_p, thickness, Δh, and thermal conductivity, k (See Page 34). The amendment of the specification uses the same physical model, the same basic heat transfer equation (13), and follows the same logic in its development as given in the original specification.

It is, therefore, submitted that the amendment of the specification as presented herewith does not introduce new matter as the Examiner asserts.

The Examiner rejected claims 1, 4, 5, 6, and 8 in view of Siniaguine et al. The Examiner alleged that this patent discloses a method for thermal processing of a substrate in which a substrate is moved through a hot gas stream at a velocity which results in a temperature differential formed throughout the thickness of the substrate.

That is not a correct summary of Siniaguine et al., which describes, as explained below, a disclosure that is quite contrary to Applicants' invention. Siniaguine et al. in WO 97/45856 calculates a temperature differential that is in a direction that is *along the surface of the wafer* to derive motion parameters for uniform treatment. The disclosure of WO 97/45856 assumes there is no temperature differential through the thickness of the wafer. See page 4 starting at line 3 of Siniaguine et al WO 97/45856, where it is stated that the wafer has a uniform temperature distribution in volume.

Applicants as set forth in claim 1 create a temperature differential within the wafer subjected to the hot gas stream and require such differential in order to enable the wafer material to quench heat from the incident hot gas stream.

Hence, there is no disclosure in Siniaguine et al. that would support a teaching of a temperature differential throughout the thickness of the wafer. In the absence of such teaching, Siniaguine et al. cannot render the rejected claims obvious.

Applicants have made an invention which, contrary to what those skilled in the art have described, such as at page 4 starting line 3 of Siniaguine et al., WO 97/45856, involves a process and system for thermal processing that will operate in a markedly different regime.

In the instant invention starting at page 26, Applicants disclose a processing regime that:

1. Gives a large temperature differential through the wafer thickness, see the page 28 discussion.
2. Gives extremely rapid, millisecond, cool-down rates of the wafer surface that are not otherwise possible, see discussion starting on page 29.
3. Prevents thermally induced defects through an entirely different mechanism from that discussed by Siniaguin et al., see Applicants discussion starting on page 32.

In summary, Siniaguine et al. fails to render Applicants invention obvious. Reconsideration of the rejection of claims 1, 4, 5, 6, and 8 is courteously requested.

Claim 7 is directed at the use of an extension as shown at 140 in Figure 17C and described in Applicants specification at page 39. Claim 7 has been rejected as obvious in view of Siniaguine et al. WO 97/45856 and WO 97/45862. It is understood that the Examiner is asserting that the '862 reference teaches an extension as illustrated at 140 in Figure 17C. However, no such extension is shown in the cited prior art and reconsideration of this rejection of claim 7 is requested.

Claim 2, which is directed at using a hot gas stream whose power density is above about $5x10^7$ W/m^2, has been rejected as obvious in view of Siniaguine et al. WO 97/45856 and Zorina et al. US patent 5,474,642. It should be noted here that Claim 2, which depends upon claim 1, requires that, in addition to the use of a power density that is above a particular level, the substrate is moved through the hot gas stream so as to establish a large temperature differential through the wafer thickness. As noted above Siniaguine et al. WO 97/45856 does not teach or disclose such temperature gradient.

Zorina et al describes an apparatus for treating a wafer with a hot plasma and avoiding plasma damage by moving the wafer through the plasma jet at a high speed while controlling the cross-sectional size of the plasma jet. There is no mention in Zorina et al. of establishing a temperature differential within the bulk wafer material. Hence, the Examiner's purpose of combining this reference with Siniaguine et al. WO 97/45856 is to show that using a power density of $5x10^7$ W/m^2, as set forth in Claim 2, should be obvious to one skilled in the art.

However, Zorina et al. recognizes that its support 8 for the wafer requires a cooling down, page 3 of the submitted copy of Zorina et al., thus actually teaching that the primary heat removal mechanism from the substrate is to conduct heat through the wafer to the support 8. This would in effect create a uniform temperature through the bulk material. Zorina et al further teaches to cool the support 8 to a starting temperature with a 5 to 10 second delay when outside the treatment zone. This cooling as taught by Zorina et al. tends to slow the processing of the wafer. Hence, Zorina et al fails to recognize and teach Applicants' invention, namely, that a high power density, whether at 10^7 W/m^2 or at $5x10^7$ W/m^2, could be beneficial and effective to create a temperature gradient within the bulk material, which then enables a speeding up of a thermal treatment of the wafer because the cooler side of the wafer can rapidly quench the heat imparted to the surface of the wafer by the treating medium.

In summary, it is submitted that, in the absence of a teaching by either Siniaguine et al., WO 97/45856, or Zorina et al., US patent 5,474,642, of creating a temperature gradient within the wafer material, the combination of these references fails to teach Applicants' invention as set forth in claim 2. Re-consideration of the rejection of claim 2 is courteously requested.

Claim 3 has been rejected on the basis that it was amended to use a corrected formula that included new material. Although Applicants disagree with the Examiner's finding of new material, it is submitted that the current amendment of claim 3 obviates this rejection and that, therefore, claim 3 is allowable.

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In view of the above amendment of claims and discussion of the rejection of claims 1 through 10 and the cited art, it is submitted that there is no teaching in the art of creating a temperature gradient throughout the thickness of a wafer during its thermal processing with a hot gas stream to enable the bulk material of the wafer to quench imparted heat. It is submitted, therefore, that all claims in the case are patentable and early favorable re-consideration of the rejections of claims 1-10 is requested.

Respectfully submitted,

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